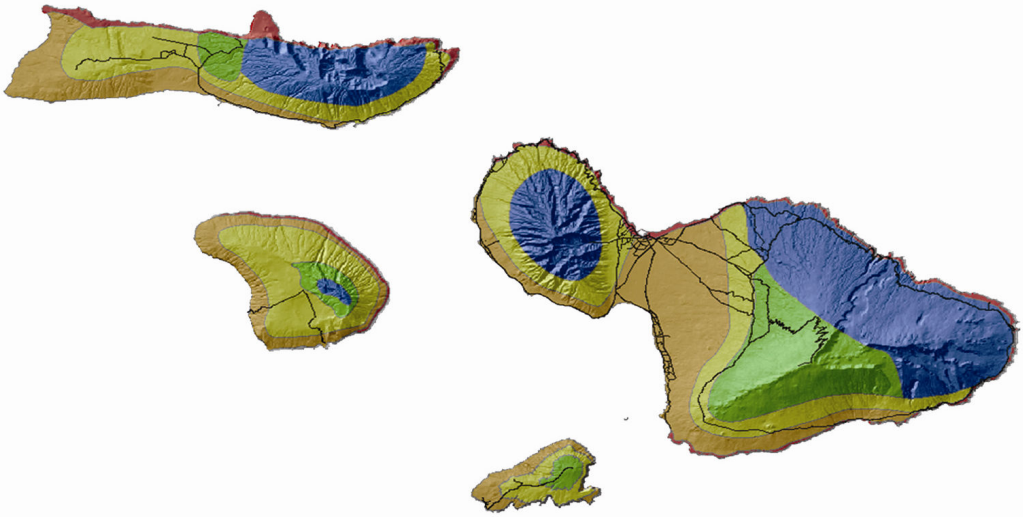
Maui County's Landscape and Gardening Handbook



Water Conservation in the Landscape

Department of Water Supply
200 South High Street
Wailuku HI 96793
www.mauiwater.org

By Water All Things Find Life

Maui County's Landscape and Gardening Handbook

Xeriscaping in Maui County

Xeriscaping is a water conservation practice in the landscape. The word xeriscaping is a word combination of xeros, Greek for dry, and landscape. It does not mean a sea of sand and gravel, and it is not a "zero"-scape. In the simplest sense xeriscaping is landscaping with plants whose natural requirements are appropriate to the local climate. Ideally xeriscaping can help to reduce or eliminate the need for supplemental irrigation.

Xeriscape seven basic principals:

- Planning and design
- Hydrozones
- Plant selection
- Soil Preparation
- Mulching
- Efficient irrigation
- Appropriate maintenance

If your area enacts water restrictions during times of drought, your landscape will be well prepared to continue to prosper within those watering restrictions. When traditional yards are turning brown and dying, your garden will continue to thrive.

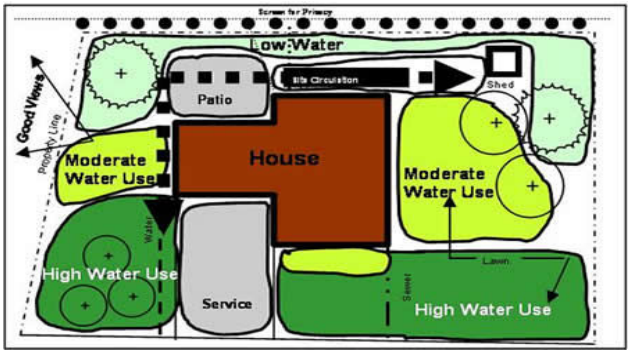
Maui Nui Botanical Gardens is an educational facility that specializes in xeriscape design.
Photo Courtesy of Maui Nui Botanical Gardens

Planning and Design

There is no single cookie-cutter design to guarantee a successful landscape. Developing a design appropriate to your geographic location will mean the difference between success and failure. Always try to work with the natural features of your landscape.

Things to consider when planning your garden:

- Which areas of your garden have shade throughout the day?
- Which areas of your garden have shade during part of the day?
- How do your shade patterns change throughout the year?
- Which areas of your garden are open slopes that do not collect water?
- Which areas of your garden are flat and collect some rainwater?
- Which areas of your garden have natural water collection (low areas or areas with natural borders that facilitate water collection)?



A hydro-zone plan can help you visualize your properties hydrological characteristics and use that information to guide your plant selection and irrigation.
Photo Courtesy of Fort Lewis College

Hydro-zones

Xeriscapes take advantage of the natural climate conditions in your yard to reduce irrigation. Different areas of your yard have different water needs. Each of these areas is called a "hydro-zone". Each hydro-zone has a micro climate that is affected by moisture, sun,

shade, air movement, heat, soil type and slope. You need to irrigate them separately from one another to keep from drowning some plants while others are dying of thirst. Remember that over-watering plants can be as harmful to them as under watering. Many plant diseases are the direct result of over-watering, particularly fungus and molds.

Tips for hydro-zones

- Reflected light from structures facing the area of most sun creates high temperatures and increases the loss of water from nearby plantings. Shade trees and ground covers that are strategically placed to block the exposure of a building to sun can reduce temperatures of the planting area and the building.

- Water loving plants can be grown in a hydro-zone where irrigation and other water runoff is captured by earthen dams to create a drainage swale, reducing the need for heavy watering.

- Grassed areas frequently require the greatest amount of watering. The general idea is to limit grass turf as much as possible. Turf is best separated from planting of trees, shrubs, ground covers, and flowering plants, so that it may be irrigated separately. If you are not using an area of turf regularly replace the turf with other, less water-demanding materials such as ground covers, low water-demanding plants or mulches.

Plant Selection and the Maui County Planting Zones

Become knowledgeable of the plants that will grow well in your area. In this handbook is a native plant selection guide based on the type of plant (tree, shrub, etc.), its water use, and the zone you live in. Each area of the island is designated a zone based on its annual rainfall. These zones are designed to be a general planting guide for Maui County. In addition to looking at the map, read the descriptions of the zones to decide which zone matches your area best. Some plants are listed in more than one zone and can be planted in a variety of conditions. Take notes on rainfall, wind, sun, and salt conditions in your area. Be sure to research more on each plant you choose to better care for its ecological needs.

Plant Selection Tips

- Choose the healthiest specimens in nurseries.
- Be sure to note that the plants roots are not pot-bound, or else the roots circle endlessly instead of spreading out into the soil in search of water and nutrients.
- Smaller, younger plants may result in a low rate of survival.
- Over-planting tends to be a big problem in landscaping due the underestimation of a species' height, width, and/or spread.
- When planting in a mixed ecosystem, keep in mind the ecological and space requirements of each plant in the system. Start with the hardiest species you will be using, but allow space for fragile ones in subsequent plantings.

A reputable nursery is the best place to acquire native plants.
Photo Courtesy of Maui Nui Botanical Gardens

Maui County Planting Zone Descriptions

Zone 1: Wet areas on the windward side of the island. More than 40 inches of rain. Higher than 3000' feet. Haiku, Huelo, Olinda, Keanae, Nahiku, Hana, and the upper west Maui mountains.

Zone 2: Cool dry areas in climates higher than 1000' foot elevation. 20 to 40 inches of rain per year. Upper Kula, Ulapalakua, and Leeward Haleakala above 1000' feet.

Zone 3: Low, drier areas, warm to hot. Less than 20 inches of rain per year. Sea to 1000' elevation. Kahalui, Kihei, Lahaina, Olowalu, Central, and Leeward Maui.

Zone 4: Lower elevations which are wetter due to proximity of mountains. 1000' to 3000' elevation. Haliimaile, Makawao, Pukalani, Lower Kula, Waiehu, Waihee, Wailuku, and Waikapu.

Zone 5: Salt spray zones in coastal areas. Sea level to 500'

Acquiring Natives

The best and easiest way to obtain plants is from a reputable nursery (see nursery list). Plants in their wild habitat must be protected and maintained. It is illegal to collect wild plants and seeds without the proper permits. It is best that you obtain plants for your landscape from local nurseries, friends, and plant sales. If you do acquire the proper permits to collect from the wild, remember to collect sparingly from each plant, and know what you are collecting. Some plants are on the Federal and State endangered species lists and require additional permits in order to collect. Tread lightly on other foliage in the collection area. Research the most effective propagation methods for each different plant before you go collecting. Transplanting wild plants is NOT a propagation method and is highly discouraged. Also, it's important to consider that many native species have subspecies that are unique to a specific area. When planting natives, try to use a subspecies that is native to that area. Contamination of native subspecies is especially common with beach naupaka.

Propagation

There are many ways to propagate native Hawaiian species. One of the most helpful books is Heidi Bornhorst's book, *Growing Native Hawaiian Plants*. Some natives are often difficult or expensive to obtain and thus advance gardeners often turn to propagation. Methods for propagation include seed gathering, cuttings, division, air layering, grafting, and tissue culture. If you are interested in propagation methods University of Hawai'i at Manoa College of Tropical Agriculture and Human Resources department maintains the Hawaiian Native Plant Propagation Database Online. This online database summarizes methods and provides citations for propagating each individual native species.

Invasive Plants

One of the major threats to Hawaii's native species and forests is the rampant spread of a large number of invasive alien plant species across the state. These plants displace Hawaii's distinctive native flora, resulting in the loss of diverse native forests that support a large array of native animals. To preserve the array of native plants and animals that make Hawaii unique we must confront the problem of invasive alien plant species.

Invasive species arrive in Hawaii for a variety of reasons, but by far the most important reason for introduction is horticultural use for ornamental purposes. In fact, this single pathway of entry accounts for approximately 70% of all documented invasive plant species in Hawaii. Other pathways of lesser importance include introductions for use as crops, livestock forage, or forestry species, and accidental introduction of weed seeds as contaminants in other products.

Soil Preparation

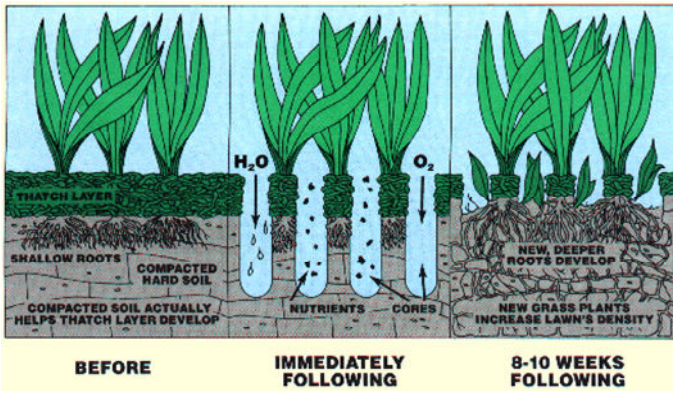
Proper soil preparation will help assure a successful garden. You may be anxious to start planting, but establishing a solid soil foundation is essential to any landscape project. There are two primary aspects to soil preparation.

Aeration

Compaction of the soil is a big problem contributing to many problems. Soils that leach water too fast, such as sandy costal soils, can also cause problems as well. Plants will perform poorly in the hard packed red clay soils that are common in some areas Maui County. Many new homes have compacted soil that should be tilled prior to planting. When planting in your soil it must be properly aerated to allow for deep penetration of water and roots. This allows your plants to establish themselves and tolerate low water periods. Volcanic cinder is a great aerator that most natives are familiar with. When planting in costal areas the sandy soils often have more than enough aeration and may require moisture retention materials such as vermiculite or water crystals to prevent the water from traveling below the reach of the roots. It would be wise to dig planting holes at least double the width and depth of the root ball. For preexisting lawns, we highly recommend core aeration of grassed turf.

Benefits from aeration include:

- Reduced soil compaction
- Stimulates root health and growth
- Allows oxygen to get into the soil
- Allows water and fertilizer to get to the roots
- Decreases water runoff
- Allows the plants to become more heat and drought resistant



Shows the core aeration method for existing turf.
Photo Courtesy of Schulhoff Tree and Lawn Care

Fertilizers

A proper balance of nitrogen (N), phosphorus (P), and potassium (K) and micro nutrients is critical in supplying the building blocks plants need to develop and establish themselves properly. However, native plants do not need very much fertilization. In fact, over-fertilization can harm or even kill native plants. If you want to fertilize your native plants, it's best to apply it at half the recommended dosage. Before you add fertilizer its good to get a soil test to determine which minerals your particular soil needs. You can buy a soil testing kit from the garden section of most hardware stores. University of Hawaii can also provide this service. Information on where to send your sample is located at the end of the document in the *where to get help* section.

Adding compost and manure to the soil is another way to add nutrients without the adverse affects of inorganic fertilizers and it will also improve the soil structure. In addition, you can use azomite for providing trace minerals. Solid organic fertilizers work well when you are preparing a soil for planting. When you want to fertilize a mature plant use a liquid fertilizer such as bat guano or sea kelp so that the nutrients can reach the roots. Organic fertilizers tend to promote more root growth and inorganic fertilizers tend to promote leafy growth. Seaweed can be collected from the beach and allowed to rot in a container with water, thus obtaining organic seaweed fertilizer in about 2 months.

Woodchips used as mulch around plants helps to keep in moisture and reduce weed growth.
Photo Courtesy of HorticMan LTD

Mulching

Mulching is the use of organic and inorganic materials to create a layer or barrier on top of your soil. Common inorganic mulch materials are mulch rock chips such as various lava rock types, coral chips and plastic coverings. Large, thick plastics meant as weed barriers are not appropriate. Plastic sheets should be semi-permeable to provide the equivalent benefits of natural mulch. Common organic mulch materials are wood chips, bark chips and compost. There are two main benefits in creating a mulch barrier.

The main benefit is to control water evaporation. A layer of mulch material (organic, rocks, plastic, etc.) will keep the ground moist. The more water you retain in the soil, the bigger the benefit to your plant's root structure. Roots will also grow deeper and stronger when provided with sufficient water and moisture. The second major benefit of mulching is to create a natural weed barrier. The lack of sunlight penetrating the mulch layer is usually all you need to prevent unwanted growth of weeds.

Irrigation

Proper irrigation is crucial to allow your garden to establish itself. Most plants will establish themselves within a month or two for most plants; however it can take up to a year for some trees. After plants are established you can reduce watering dramatically. Over-watering and nighttime watering may actually cause some diseases.

Tips for Water Wise Watering

- Air-conditioning units can produce up to several gallons of condensation a day depending on the model and type; use it to irrigate your yard.
- Water deeply every few days instead of lightly every day.
- Don't trim your grass too short. Exposing the lawn to the sun will increase the water loss due to evaporation. Longer grass has deeper roots and requires less water.
- Water late in the day and never on dry or windy days to minimize the water lost through evaporation.
- Install a trigger nozzle on your hose.

Micro-sprinkler irrigation

Micro-sprinkler irrigation is the most effective and efficient method for delivering water where it is needed and in the appropriate amounts. The term "micro-irrigation" describes a family of irrigation systems that apply water through small devices. These devices deliver water onto the soil surface very near the plant or below the soil surface directly into the plant root zone. The most common devices deliver water in three different modes: drip, bubbler, and micro-sprinkler. In drip mode, water is applied as droplets or trickles. In bubbler mode, water `bubbles out' from the emitters. Water is sprinkled, sprayed, or misted in the micro-sprinkler mode. Systems can be adapted to supply individual areas based on their water requirements. Ideally, water is applied to the root zone in quantities that are approximately equal to the

amount of water required to meet the needs of the plant. This avoids deflection from plant leaves.

Micro-sprinklers are very efficient. Water is delivered directly to the roots through drip tubes.
Photo Courtesy of Clemson University

Smart Controllers

Water evaporates from the dirt. Plants use transpiration of soil moisture to cool themselves like humans use perspiration. Plants also use water in photosynthesis. Smart controllers measure these water losses from the landscape. There are two basic types of smart controllers, ET controllers and soil moisture sensor controllers.

ET Controllers are irrigation controllers which use some method of weather based adjustment of irrigation. These adjusting methods include: use of historical monthly averages of ET; broadcasting of ET measurements; and use of on-site sensors to track ET. Maui has six weather regions available by broadcast. ET controllers can help dramatically lower water consumption by creating an intelligent irrigation schedule that is just right for your landscape requirements. Soil moisture sensor controllers use a sensor that is embedded into the soil to detect the presence or absence of water and adjusts the watering to match a predetermined moisture level.

Deep Soaking and Cycle Irrigation

Maui, Lanai, and Molokai's clay soils can only absorb a limited amount of water at one time and most native species do poorly in waterlogged soils. Even plants that can survive extremely wet environments do not require that level of irrigation to thrive. The following water irrigation practices can help you save water and grow healthy vegetation.

Do not water if the soil is damp. Water plants with a deep soaking when the soil is dry and the plants are wilting. Deep soaking encourages the development of stronger and deeper root systems. Frequent shallow watering encourages weaker, shallower root systems.

Overwatering your landscape?
Photo Courtesy of Austin Water Utility Conservation Program

The best way to deep soak is to water you plants using cycle irrigation. Cycle irrigation reduces runoff and allows more water to be absorbed, resulting in deeper root growth and more drought-tolerant landscape. Cycle irrigation uses multiple start times, running through a multiple cycle of zones more than once per watering day. For example, instead of watering an entire zone for 20 minutes, set up three start times of 6 minutes each for a total of 18 minutes or two start times of 9 minutes each for a total of 18

minutes. Set start times so that there is an hour in between cycles, and adjust the length of time you water each zone so that no runoff or surface pooling occurs.

Even the most water thirsty plants found in Hawaii do not require daily watering if cared for properly (water cycling, mulch, groundcovers, etc.). The following watering schedule was taken from Kenneth Nagata's Booklet, *How to Plant a Native Hawaiian Garden* and adapted for use with the plant selection guide water requirement levels.

Maintenance

Water Requirement	Watering Day Frequency
Wet	Three times per week
Med	Two time per week
Dry	One time per week or less

Composting

Yard waste can be recycled into high-quality compost. This minimizes trips to the landfill and encourages wise resource use. Choose a well-drained corner of the yard that is convenient to the kitchen and out of sight. Clear the area to expose the soil. Commercially prefabricated composters are available, but compost bins fairly easy to build.

Tips for composting

- Remember to use inexpensive materials.
- Allow for air circulation
- Make the bin wide enough to turn and lift compost.
- Black soldier fly larvae and worms can make your composting more effective.

You can use chicken wire, woven wire, or inexpensive fencing to build a bin. Discarded wood pallets can be put together with wire to make an inexpensive rectangular bin. Cinder blocks or brick can be used if gaps are left to allow air circulation.

Mow correctly

Mow the grass when it is about 1/3 higher than the desired height. Clippings can be left where they fall, recycling nutrients into the soil. If clippings are collected, compost them with raked leaves and organic kitchen waste. Never mow lawns too short. Proper mowing heights can help lawns use less water. Grass cut too short is stressed and dries out quickly.

Kitchen and yard waste in a compost bin
Photo courtesy of Karim Nice

Fertilize wisely

Many native plants do not need fertilizer since they are adapted to natural soil conditions. Other plants, such as non-native grasses and vegetables gardens, need additional nutrients for healthy growth. Use recycled lawn clippings, compost, Dillo Dirt, or slow-release encapsulated nitrogen on lawns.

Integrated Pest Management

Integrated Pest Management (IPM) takes advantage of natural methods of pest control. This protects soil from contamination, wildlife from harm, and waterways from being polluted with non-point source pollution. Chemical controls will destroy beneficial insects as well as harmful ones.

Organic pest control such as insecticidal soaps and manual methods such as pulling weeds or using sand barriers may do the job. Beneficial insects such as ladybugs, beetles, preying mantis, and dragonflies should be encouraged and can even be introduced into a landscape.

Other Interesting Techniques for the Ambitious

Xeriscape Water Features

Water features in a Xeriscape Garden you say? Yes! It's hard to imagine that something that holds water doesn't really use very much water, but it's true. In our climate, water is a constant concern; with cyclical drought conditions in some areas many residents are afraid to include a pond in their landscape. After all, ponds need a lot of water, right? Wrong. Ponds, after the initial filling, require half as much water as the same area of grass lawn and are much more environmentally conscious. Ponds provide a vital water supply for birds and other wildlife. They don't require pesticides or chemical fertilizers that can be harmful to the environment and a pond can be peaceful and relaxing. A pond can be very compatible with xeriscape plantings; it's just a matter of water wise usage.

Tips for Water Saving Ponds

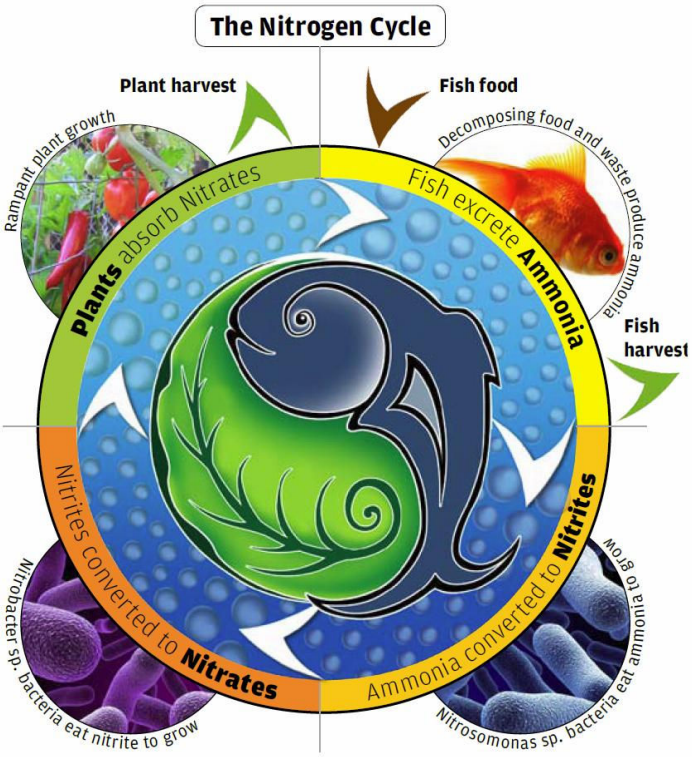
- When designing a water feature take care to minimize the surface area of exposed water to limit evaporation. Pondless water courses can help to limit evaporation losses while still providing aesthetic value.
- Waterproof linings, if properly installed, can prevent virtually all leakage.
- Check liners, fittings, and pumps for leaks regularly.
- Put all waterfalls and fountains on timed switches so they only run when you're home to enjoy them. Evaporation is increased when fountains and waterfalls are running, due to the increased surface area of the pond water.
- Disconnect auto-refill devices so you are aware of water usage. With auto-refilling it's impossible to know how much water the pond is using until you get your water bill.
- Refill your pond with water collected from your roof or from your AC unit.
- Vent your pond overflow into your garden.
- Put your pond in the shade to prevent exposure to direct sunlight. Also you can put plants in and around your pond to provide shade.
- Cover your pond; ponds loose water to evaporation. Limiting the surface area that is exposed to the air will save water.

A water feature can instantly transform your garden, providing a beautiful focal point.
Photo Courtesy of hawaiigardening.blogspot.com

Aquaponics in the Backyard

Aquaponics is the integration of recirculation fish culture with hydroponics plant production. In Aquaponics, nutrient-rich water is seen as a commodity instead of a waste, and is used to grow food plants. The wastes from the fish are broken

down by bacteria living in the growing medium, and converted into a form that can be used by the plants. Once the plants have utilized the nutrients, the water is returned to the fish for further fish culture, and the perpetual cycle begins again.



This figure shows the cycle that occurs in aquaponics.
Photo Courtesy of Vino

Aquaponic systems do not discharge or exchange water. The systems rely on the natural relationship between the aquatic animals and the plants to maintain the environment. Water is only added to replace water loss from absorption by the plants, evaporation into the air, or the removal of biomass from the system. A small backyard aquaponics system can supply an entire households worth of veggies and herbs, plus a supplemental protein source. For help with constructing your own system contact the University of Hawaii aquaculture extension agent. Information on how to contact them is available in the where to get help section.

The Advantages of Aquaponics

- It is the most water efficient form of agriculture known. (up to 90% less water than soil)
- There are near zero environmental impacts.
- Systems are typically highly space efficient and suitable for intensive urban agriculture.
- Plant growth is substantially greater than that of soil based agriculture.
- Has the ability to grow two crops (fish and plants) off of one food source (fish food)..

Water Polymer Crystals

Water Polymer Crystals are crosslinked acrylic acid polymer sodium salts. The polymers absorb up to 1,000 times their weight in distilled water. Today it is used in diapers, fire control, personal lubricant, seed germination, soil conditioning, hydroponics, instant snow, and water absorption from gasoline/diesel fuel tanks.

These polymer crystals give plants the capability to survive dry, hot, and drought conditions. Their use dramatically increases the water holding capacity of your soil. The crystals capture and absorb excess moisture, alleviating runoff and storing it until needed by plants.

Water polymer crystals improve soil structure over time. Through the expansion-and-contraction cycles of the crystals, the soil is loosened and aerated. The polymer granules swell when hydrated; then, they

The photo depicts hydrated water crystals on the top and a de-hydrated powder form on the bottom.
Photo Courtesy of WaterCrystals.com

shrink, as water is drawn from them. The crystals last about 5-7 years, however inorganic fertilizer application reduces their ability to store as much water and also leads to shortened life cycle.

Irrigation Rainwater Catchment Systems

A water catchment system is a facility for collecting and storing runoff from precipitation. Its purpose is provide water for irrigation, livestock, fish, wildlife, and/or other purposes by sealing of the watersheds or contributing areas to increase, collect, and store runoff water for future use.

The photo is of a rain water collection system at the old Ho'okama building on 59 Kanoa St.
Photo Courtesy of Department of Water

Some possible watersheds include curbs and diversions constructed to collect and store runoff from such high runoff areas as rock outcrops or existing paved or impervious areas. The easiest to adapt and most common watershed available in Hawaii is your roof. If you live in a particularly dry and hot area with little rain, air-conditioning condensate from a small unit can provide a steady trickle of water that can add up to a few gallons per day. A larger central air unit can provide up to 5-10 gallons a day.

Planning and Design Tips

- The collection apron should be large enough to yield the required amount of runoff from the expected storms.
- The apron shall be smooth and impervious to insure that adequate runoff occurs. Compacted earth, treated earth, wax, rubber, plastic, asphalt, concrete, steel, and other such suitable materials are acceptable for this purpose.
- Foreign runoff should be diverted from the catchment area to prevent damage and excessive sedimentation. This is called first flush diversion. First flush diverters are available commercially, you can look at ours at 59 Kanoa St., or you can go online for designs.
- An overflow pipe or auxiliary spillway should be installed to prevent damage to the storage basin and the surrounding area.
- The storage basin should be of adequate size, impermeable, and durable to hold water for the intended purpose. Earth basins and tanks constructed of steel, concrete, butyl rubber, and similar facilities are acceptable. Earth dams should have at least 1 foot of freeboard above the design high water. Design your system to withstand the largest conceivable storm.
- The apron and storage areas should be protected from damage by weather, animals, vandals, wildlife, and traffic.
- Evaporation control measures may be needed to insure that adequate storage capacity is maintained. Covered storage and/or storage tanks to store runoff is a much more efficient solution than a large pond.

Operation and Maintenance

An O&M plan specific to the type of installed water-harvesting catchment should be developed by the landowner. The plan shall include, but not be limited to, the following provisions:

- Inspecting and testing valves, drains, etc.
- Maintaining erosion protection at outlets.
- Checking for debris, leafs, and other materials that may restrict system flow.
- Controlling all vegetation, wildlife, rodents, or burrowing animals from the apron.
- Maintaining all fences to prevent unauthorized human or livestock access.
- Inspecting the catchment area for signs of ultraviolet degradation.
- Read the UH Rainwater Catchment Guide for more information.

Dowsing for Water Lines

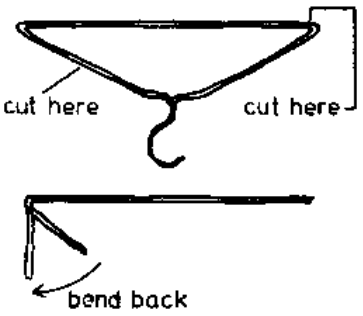
You will can use this skill for the rest of your life to position water pipes and other under ground cables and pipes. Field workers use dowsing, in addition to modern pipe locators, in cases where maps are inconsistent with what's underground. Most of the field crew at the Department of Water Supply are aware what "dowsing" is and use it regularly. Dowsing has a hocus pocus reputation; it works for some people and does not for others; and its history is very "colorful". Despite years of practical use by many people, dowsing has failed to produce empirical evidence of being more successful than chance. Despite this, we recommend giving it a try.

Making Angle Rods

The easiest way to make divining rods is to cut up a pair of old wire coat-hangers, although many say the best material is solid brass wire. To make an angle rod simply bend an ~18" piece of wire into an L shape. Experiment with materials and lengths until you discover what works best for you.

Holding the rods

The short arm of the L is the part you hold. It should be held in a loosely clenched fist. The idea is that the rod can swing freely from side to side, and hence the need for loosely clenched fists or for the sleeves. The long arms of the rods should be pointing away from you and roughly parallel to each other. This is their working or 'neutral' position.



Take two metal coat hangers, cut and bend them as shown
Photo Courtesy of Tom Graves

A Matter of Balance

Holding the 'neutral' position of the rods will seem fairly easy when you're sitting or standing still; but it's quite another matter to hold them in that position when you're walking along. If you allow the rods to sway about all over the place, you won't be able to tell if they're reacting to something interesting or only to your own lack of balance. So the first exercise is to learn how to handle the rods in practice, how to maintain a fairly stable 'neutral', and generally to see what happens when you use the rods in practice.

Practice

Just repeat that exercise from time to time in as many places as you can. Don't take it too seriously. Be

patient, give yourself a chance. Remember too that the idea of this practice is for you to learn the 'feel' of the rods, which will tell you if the rods are just wobbling about or if they are moving 'of their own accord'. When you find that you can tell the difference between movements seemingly caused by something outside of you and those caused by yourself or by the wind catching the rods move on to practical applications.

Interpretation and Meaning

Analytic interpretation of the movement is simple, for it's based on repeatability: if a dowsing reaction is repeatable under the same conditions it is held to be 'true', and the meaning of that reaction is then derived from the conditions under which it took place. To give an example, one of these conditions is place, or position: if a reaction repeatedly occurs at the same place, you can infer that something is causing the reactions at that place. . If you can't, either you're a bad dowser (you're not focused or relaxed enough, you're psychically challenged, you're holding the rod(s) incorrectly, or you're too skeptical to allow dowsing to work for you) or dowsing is nothing more than superstition punctuated by coincidence. You decide.

Position

Start with basic water-divining: finding your water meter and the line that leads into your house relative to the surface. Other recommended tools are paint and a shovel, for marking and verifying your "readings". Repeat the previous exercise of holding the rods in the neutral position while crossing and re-crossing the street-side of your house. Mark or mentally note any points of pronounced movement. Do this exercise several times, and then compare the results to see if there is a repeatability of movement at the same place. If you think you've found your service line you can verify its location by locating your water meter and comparing the position of the alleged service line and the meter. If the alleged line goes to the meter then you've found it.

Tips for divining:

- Often times the rod will move parallel with any nearby water lines. It is best to move perpendicular to suspected water line location, so that when the rod moves parallel it is more obvious.
- There are many false signals as well; power lines, above ground and below, or any electromagnetic or electrostatic object "may" affect the rods position. Beware of any nearby false signals.
- If it doesn't seem to be working at all for you, at least it didn't cost much to try.

Resources for Knowledge Enhancement

Further Reading Materials

Web sites

Department of Health Office of Environmental Quality Control, How to Plant A Native Hawaiian Garden, An On-Line Handbook
http://oeqc.doh.hawaii.gov/Shared%20Documents/Misc_Documents/1992_How_to_Plant_a_Native_Hawaiian_Garden.pdf

Hawaiian Ethnobotany Online Database
http://www2.bishopmuseum.org/ethnobotanydb/index.asp

Irrigation Tutorials, Design-Troubleshooting-Product Reviews-Saving Water Tips
http://www.irrigationtutorials.com

Native Plants Hawaii, Comprehensive Hawaiian Native Plant Database
http://nativeplants.hawaii.edu

University of Hawai'i at Manoa College of Tropical Agriculture and Human Resources Hawaiian Native Plant Propagation Database
http://pdcs.ctahr.hawaii.edu:591/hawnprop/

Books and Articles

Bornhorst, Heidi L. 1996. Growing Native Hawaiian Plants: A How-To Guide for the Gardener. Honolulu: The Bess Press.

Culliney, John L., and Bruce P. Koebele. 1999. A Native Hawaiian Garden: How to Grow and Care for Island Plants. Honolulu: University of Hawai'i Press.

Lilleeng-Rosenberger, Kerin E. 2005. Growing Hawaii's Native Plants: A Simple Step-By-Step Approach for Every Species. Honolulu: Mutual Publishing.

Ludwig, Art. 2005. Water Storage: Tanks, Cisterns, Aquifers, and Ponds; For Domestic Supply, Fire and Emergency Use; Includes How to Make Ferrocement Water Tanks.

Macomber, Patricia S.H. 2004. Guidelines on Rainwater Catchment Systems for Hawai'i. Honolulu: College of Tropical Agriculture and Human Resources, University of Hawai'i at Manoa.

Wilson, C. and Bauer, M. 2005. Drip Irrigation for Home Gardens. http://www.ext.colostate.edu/pubs/Garden/04702.html

Places to Get Help

College of Tropical Agriculture and Human Resources Extension Office
310 W Kaahumanu Ave # 214 Kahului, HI 96732-1694 (808) 244-3242

The CTAHR extension office can provide soil sample testing, insect and disease problem identification, and general garden and landscape information. They also provide many public outreach programs. To find out more call or go to

http://www.ctahr.hawaii.edu/site/Extprograms.aspx

To get a soil test, go to this site to find out what you need to do.
http://www.ctahr.hawaii.edu/TPSS/research_extension/rxsoil/soilsample.htm

Maui Nui botanical Gardens
150 Kanaloa Avenue Kahului, HI 96732-1116 (808) 249-2798 www.mnbg.org

The mission of the Maui Nui Botanical Gardens is to foster an appreciation and understanding of the living Hawaiian Islands of today, emphasizing the plants of Maui Nui (Maui, Moloka'i, Lana'i and Kaho'olawe), and providing a center for environmental education, Hawaiian cultural expression, conservation, biological study, and recreation. They can help you get ideas for your xeriscape garden because they have one that looks great. They do plant sales a few times a year.

University of Hawai'i Sea Grant College Program Aquaculture Extension Office
310 W Ka'ahumanu Ave. Kahului, Hawai'i 96732 (808) 984-3337

The Maui County aquaculture extension agent is responsible for providing technical assistance to aquaculture farmers throughout the County and is based at Maui Community College. Although currently based on Maui, the agent continues to frequent Moloka`i to offer advice and expertise in aquaculture projects.

Places to Buy Native Plants on Maui

- **Kula Ace Hardware and Nursery**
  3600 Lower Kula Road Kula, HI 96790 (808)-876-0734
- **Kihana Nursery**
  1708 South Kihei Road Kihei, HI 96753 (808)-879-1165
- **Kahanu Gardens National Tropical Botanical Garden**
  650 Ulaino Road Hana, Hawaii 96713 (808)-248–8912
- **Kulamanu Farms - Ann Carter**
  P.O. Box 1299 Makawao, HI 96768 (808)-878-1801
- **Native Gardenscapes - Robin Mcmillan**
  1330 Lower Kimo Drive Kula, HI 96790 (808)-870-1421
- **Future Forests Nursery**
  P.O. Box 847 Kailua Kona, HI 96745 (808)-325-2377 www.forestnursery.com *seed stock
- **Native Nursery, LLC - Jonathan Keyser**
  1267 Na`alae Rd. Kula, HI 96790 (808)-878-8276 www.mauinativenursery.com
- **New Moon Enterprises - Pat Bily**
  47 Kahoea Place Kula, HI 96790 (808)-878-2441
- **Native Hawaiian Tree Source**
  1630 Piiholo Road Makawao, HI 96768 (808)-572-6180
- **Ho'olawa Farms - Anna Palomino**
  3 Kahiapo Pl Haiku, HI 96708 (808)-575-5099

- **Chuck Chimera**
  PO Box 1502 Makawao, HI 96768 (808) 280-2669

Places to See Natives on Maui

The following places propagate native Hawaiian plants from seeds and/or cuttings. Their purpose is to protect and preserve these native species. Please contact them before going to view the sites; they may also be able to provide you with valuable information and referral to other sources.

- **The Hawaiian Collection**
  1127 Manu Street Kula, HI 96790 (808)-787-1701

- **Kula Botanical Gardens**
  RR4, Box 228 Kula, HI 96790 (808)-878-1715

- **Wailea Point Condominiums**
  4000 Wailea Alanui Kihei, HI 96753 (808)-875-9557

- **Kahalui Library Courtyard**
  20 School St. Kahalui, HI 96732 (808)-873-3097

- **Maui Nui botanical Gardens**
  150 Kanaloa Avenue Kahului, HI 96732-1116 (808) 249-2798 www.mnbg.org

Native and Polynesian Plants for Maui County

Plant Zone Key

Zone 1 **-** Wet areas on the windward side of the island. More than 40 inches of rain. Higher than 3000' feet. Haiku, Huelo, Olinda, Keanae, Nahiku, Hana, and the upper west Maui mountains.

Zone 2 - Cool dry areas in climates higher than 1000' foot elevation. 20 to 40 inches of rain per year. Upper Kula, Ulapalakua, and Leeward Haleakala above 1000' feet.

Zone 3 - Low, drier areas, warm to hot. Less than 20 inches of rain per year. Sea to 1000' elevation. Kahalui, Kihei, Lahaina, Olowalu, Central, and Leeward Maui.

Zone 4 - Lower elevations which are wetter due to proximity of mountains. 1000' to 3000' elevation. Haliimaile, Makawao, Pukalani, Lower Kula, Waiehu, Waihee, Wailuku, and Waikapu.

Zone 5 - Salt spray zones in coastal areas. Sea level to 500'

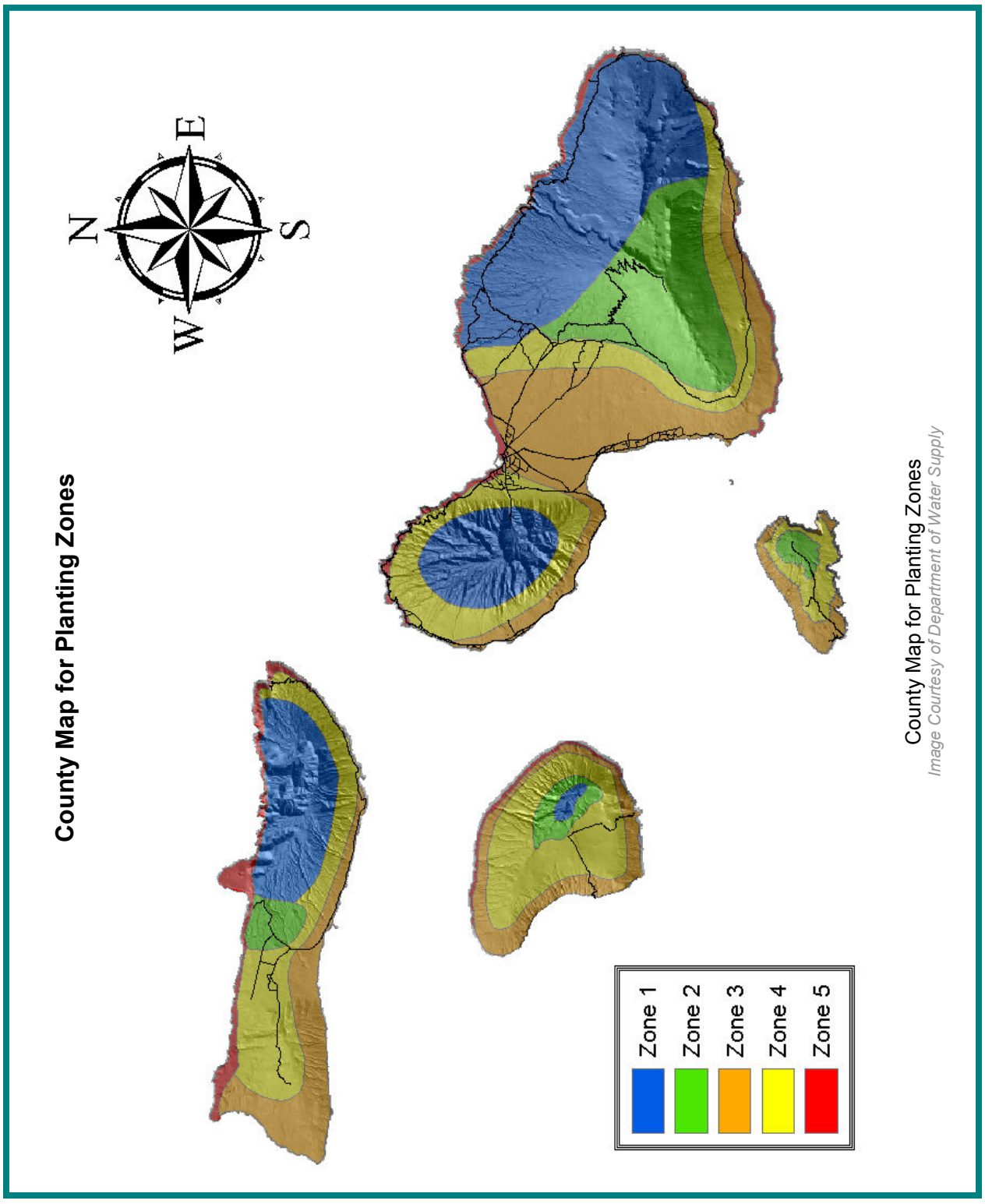
(1,2,3,4,5) - If a zone is in (parenthesis), then it may require additional watering to thrive.

Watering Key

Water Requirement	Watering Day Frequency
Wet	Three times per week
Med	Two times per week
Dry	One times per week

Island Distribution Key

EM	East Maui	Li	Lisianski Island
FF	French Frigate Shoals	M	Maui Island
GP	Gardner Pinnacles	Mi	Midway Atoll
H	Hawai'i Island	Ml	Molokini Island
HI	The eight Hawaiian Islands	Mo	Moloka'i Island
K	Kaua'i Island	N	Nihoa Island
Ka	Kaho'olawe Island	Ne	Necker Island
Kl	Ka'ula Island	Ni	Ni'ihau Island
Ko	Ko'olau Mountains, O'ahu	NWI	Northwestern Hawaiian Islands
Ku	Kure Atoll	O	O'ahu Island
L	Lana'i Island	PH	Pearl and Hermes Atoll
La	Laysan Island	Wa	Wai'anae Mountains, O'ahu
Le	Lehua Island	WM	West Maui



County Map for Planting Zones

Image Courtesy of Department of Water Supply

Plant List

Scientific Name	Common Name	Zone	Watering	Island Distribution	Growth Form	Soils
Abutilon eremitopetalum	hidden petal abutilon	2,3,4	dry to med	EL	round shrub	clay, organic, cinder
Abutilon menziesii	ko'oloa 'ula	2,3,4	dry to med	O?/ L/ EM/ H	round shrub	clay, organic, cinder
Acacia koa	koa	1,2,4	dry to med	K/ O/ Mo/ L/ M/ H	large tree	organic, cinder
Acacia koaia	koai'e	2,3,4	dry to med	K/ O / Mo/ L/ M/ H	small tree	clay, cinder, organic
Achyranthes splendens	'ewa hinahina	3,5	dry to med	O/ Mo (ex)/ L (ex)	round shrub	basalt, coral
Aleurites moluccana	kukui	1,(3),4,5	med to wet	HI	large shade tree	organic
Alocasia macorrhiza	'ape, elephants ear	1,4	med to wet	HI	root/leaf vegetable	organic, cinder, wetland
Alyxia oliviformus	maile	1,2,4	med to wet	HI	vine, shrub	organic
Antidesma pulvinatum	hame	1,(3),4	dry to wet	O/ Mo/ M/ H	medium tree	organic, clay
Argemone glauca dicipiens	pua kala, pricky poppy	2,3,4,5	dry to med	H	clumping shrub	cinder, organic
Argyroxiphium grayanum	greensword	2	dry to wet	WM/ EM	rosette shrub	cinder, organic
Artemisa australis	ahinahina	3,4,5	dry to med	HI	clumping shrub	cinder, sand
Artemisa mauiensis diffusa	ahinahina, Maui wormwood	2,4	dry to med	EM	clumping shrub	cinder
Artocarpus altilis	breadfruit, ulu	1,(2,3),4	med to wet	HI	large shade tree	organic
Asplenium nidus	ekaha	1,(3), (4)	med to wet	HI exc. Ni, Ka	round fern	organic, cinder
Astelia menziesiana	kaluaha	(2),4	med to wet	K/ O/ Mo/ L/ M/ H	clumping epiphyte	organic
Bacopa monnieri	ae ae, water hyssop	1,(3),5	med to wet	Mi/ Ni/ K/ O/ Mo/ L/ M/ H	creeping herb	wetland, organic
Bidens hillebrandia	ko'oko'olau	1,(3),5	dry to med	Mo/ EM	spreading shrub	cinder, basalt
Bidens mauiensis	ko'oko'olau	3,5	dry to med	L/ M/ Ka	spreading shrub	cinder, basalt
Boerhavia repens	alena	3,5	dry to med	Ku/ Mi/ PH/ Li/ La/ FF/ N/ HI	creeping herb	coral chips, cinder
Bolboschoenus maritimus	kaluha	(3),5	med to wet	Ni/ K/ O/ Mo/ M/ H	clumping grass	organic
Bonamia menziesii	bonamia	2,3,4,5	dry to med	K/ O/ Mo (ex)/ L/ M/ H	crawling shrubby vine	clay, cinder, organic
Brighamia rockii	alula	3,5	dry to med	Mo/L (ex)/ M(ex)	mono-stem succulent	cinder, basalt, organic
Broussonetia papyrfera	wauke, paper mulberry	(3),4	dry to med	HI	shrub like tree	organic
Caesalpinia bonduc	uhiuhi	2,3,4	dry to med	La/ Ni/ K/ O/ Mo/ EM/ H	shrub-like tree	organic

Uses	Propagation	Federal Status	Distribution Status	Height	Spread	Elevation
N/A	seed, cutting	endangered	endemic	5'	8'	1500' to 5000'
juice of flower is a laxative, lei	seed, cutting, air layers	endangered	endemic	10'	5'	1500' to 5000'
fuel, canoes, kahili handle, dye	seed	no status	endemic	100'	80'	1500' to 4000'
wood, medicinal, lei	seed	no status	endemic	20'	25'	150' to 4000'
N/A	seed, cutting	endangered	endemic	6'	5'	sea to 3000'
oil, tattoo, glue, lei, canoe	seed	no status	polynesian	50'	50'	sea to 3000'
the leaves eaten once cooked	cutting	no status	polynesian	8	6	sea to 4000'
medicinal, fragrant lei	seed	no status	endemic	vine	vine	sea to 6000'
dye, wood	seed, cutting	no status	endemic	25'	15'	30' to 4000'
seeds and sap used as narcotic	seed	no status	endemic	3'	2'	sea to 3000'
N/A	seed	no status	endemic	6'	1'	4000' to 6000'
N/A	seed, cutting	no status	endemic	2'	3'	sea to 3000'
N/A	seed, cutting	no status	endemic	2'	3'	1000' to 9000'
food, glue, chewing gum, canoe, surf-board, dye	air layers, root cutting	no status	polynesian	50'	40'	sea to 5000'
religious ceremonies, decoration	spores, tissue culture	no status	native	2'	5'	sea to 1000'
thatch, lei	seed	no status	endemic	6'	3'	2000' to 7500'
medicine (nootropic)	cutting	no status	native	6"	4'	sea to 1000'
tea for asthma and stomach pain	seed	no status	endemic	1'	2'	sea to 1000'
tea for asthma and stomach pain	seed	no status	endemic	1'	3'	sea to 1000'
flypaper, food, medicine	seed, cutting	no status	native	6"	4'	sea to 1000'
wetland stabilization, food, weaving	seed, division	no status	native	2'	20'	sea to 1500'
N/A	cutting	endangered	endemic	10'	50'	sea to 3000'
lei	seed	endangered	endemic	2'	1'	sea to 1500'
kapa, cordage, lamp wick	seed, cutting	no status	polynesian	8'	6'	sea to 1000'
lei, wood	seed	no status	native	30'	20'	250' to 3000'

Scientific Name	Common Name	Zone	Watering	Island Distribution	Growth Form	Soils
Caesalpinia kavaiensis	uhiuhi	2,3,4	dry to med	K (ex)/ O/ L (ex?)/ WM (ex)/ H	shrub-like tree	organic
Calophyllum inophyllum	kamani, alexandrian laurel	1,(3),4	med to wet	HI	dense tree	sand, coral, organic
Canavalia hawaiiensis	'awikiwiki	2,3,4	dry to med	L/ M/ H	crawling vine	sand, coral, cinder
Canavalia molokaiensis	'awikiwiki	2,(3),4	dry to med	Mo	crawling vine	sand, coral, cinder
Canavalia pubescens	'awikiwiki, lavafield jackbean	2,3,4	dry	Ni/ K/ L/ EM	crawling vine	sand, coral, cinder
Capparis sandwichiana	maiapilo, pua pilo	2,3,4,5	dry to med	Mi/ PH/ La (ex)/ HI	spreading shrub	sand, cinder, organic, coral
Carex alligata	hawaiian sedge	(3),4	wet	K/ O/ Mo/ M/ H	clumping grass	organic
Carex meyenii	hawaiian sedge	2,3,4	med to dry	HI [Ka (ex)]	clumping grass	organic, clay, cinder
Chamaesyce celastroides	'akoko	3,4,5	dry to med	L (r)/ M	spreading shrub	basalt
Chamaesyce degeneri	akoko	3,5	dry	Ni/ K/ O/ Mo/ M/ H	sprawling shrub	sand, cinder, coral, clay
Chamaesyce skottsbergii	'akoko	3,4,5	dry to med	O/ Mo	spreading shrub	basalt
Charpentiera obovata	papala	1,2,4	dry to wet	K/ O/ Mo/ L/ M/ H	small to medium tree	cinder, organic
Cheirodendron trigynum	'olapa	1,2,4	med to wet	Ni/ O/ Mo/ L/ M/ H	medium evergreen tree	cinder, organic
Chenopodium oahuense	'aheahea, 'aweoweo	2,3,5	dry to med	Li/ La/ FF/ Ne/ N/ HI	tree-like shrub	cinder, coral, basalt
Chrysopogon aciculatus	pilipiliula, golden beard grass	3,5	dry to med	K/ O/ Mo/ L/ WM/ H	mat forming turf grass	N/A
Cibotium chamissoi	hapu'u	1,2,(3),4,	med to wet	O/ Mo/ L/ M/ H	tree fern	cinder, organic
Clermontia arborescens	oha wai	1,2,4	med to wet	WM/ EM	epiphytic shrub	organic
Clermontia kakeana	oha wai	1,2,4	med to wet	L/ Mo/ M	epiphytic shrub	organic
Cocculus orbiculatus	huehue	3,4,5	dry to med	Ni/ K/ O/ Mo/ L/ M/ H	sprawling vine	cinder, coral
Cocos nucifera	niu, coconut palm	1,3,4,5	dry to wet	HI	large palm	sand, cinder, coral, bassalt
Colocasia esculenta	taro, kalo	1,(3),4	dry to wet	HI	root/leaf vegetable	organic, cinder, wetland
Columbrina asiatica	'anapanapa	(3),4,5	dry to wet	Ni/ K/ O/ Mo/ WM	vine-like shrub	sand, organic
Coprosma ernodeoides	kukaenene	1,2,3,4	dry to wet	WM/ EM/ H	spreading shrub	cinder
Corida subcordata	kou	1,(3),4,5	dry to wet	Ni/ K/ O/ L/ M/ H	small tree	sand, clay, limestone, cinder
Cressa truxillensis	makihi	3,5	dry to med	O/ Mo/ Ka	creeping herb	sand, coral, cinder

Uses	Propagation	Federal Status	Distribution Status	Height	Spread	Elevation
lei, wood	seed	endangered	endemic	30'	20'	250' to 3000'
poi bowl, scent, whistle, oil	seeds	no status	polyneisan	60'	40'	sea to 3000'
lei	seeds, cutting	no status	endemic	vine	vine	sea to 2000'
lei	seeds, cutting	endangered	endemic	vine	vine	sea to 2000'
lei	seeds, cutting	candidate	endemic	vine	vine	sea to 2000'
medicinal, flowers used in lei	seed	no status	endemic	4'	10'	sea to 6000'
N/A	seed, division	no status	endemic	2'	3'	2000' to 5000'
N/A	seed, division	no status	native	2'	3'	2000' to 5000'
N/A	seed	no status	endemic	2'	3'	sea to 1000'
firewood, paint, medicine	seed, cutting	no status	endemic	4'	2'	sea to 1000'
N/A	seed	endangered	endemic	6"	2'	sea to 1000'
used as fireworks for 'ohai game	seed	no status	endemic	15'	5'	500' to 5000'
dye, lei, wood	seed, cutting	no status	endemic	25'	25'	2000' to 7000'
leaves are cooked, death prayers, medicine	seed	no status	endemic	6'	4'	sea to 9000'
N/A	seed, vegetative transplant	no status	native	6"	2'	sea to 1000'
pillow stuffing, food, medicine	cutting	no status	endemic	30'	15'	sea to 6000'
leaves and berries are food, latex for bird traps	seed, cutting	no status	endemic	10'	6'	1000' to 6000'
leaves and berries are food, latex for bird traps	seed, cutting	no status	endemic	10'	6'	1000' to 6000'
cordage	seed, cutting	no status	native	vine	vine	sea to 2000'
cordage, scent, oil, drum, food	seed	no status	polynesian	100'	30'	sea to 1000'
the entire plant can be eaten once cooked	cutting	no status	polynesian	3'	2'	sea to 4000'
soapy lather, medicinal	seed, cutting	no status	native	3'	10'	sea to 1000'
dye, lei	seed, cutting	no status	endemic	1'	2'	100' to 9000'
bowls, dye, lei, edible seeds	seed	no status	native	30'	25'	sea to 1000'
N/A	seed	no status	native	6"	1'	sea to 1000'

Scientific Name	Common Name	Zone	Watering	Island Distribution	Growth Form	Soils
Cordyline fruiticosa	ti, ki, la'i	1,2,(3),4	dry to wet	HI	dense upright shrub	organic, cinder, coral chips
Curcuma longa	olena, tumeric	1,(3),4	dry to wet	HI	spreading herb	cinder, organic
Cuscuta sandwichiana	kauna'oa	3,4,5	dry	Ni/ K/ O/ Mo/ L/ M/ H	parasitic vine	host plant
Cyperus laevigatus	ehu'awa	3,5	med to wet	La/ Ni/ O/ Mo/ M/ H	spreading grass	sand
Cyperus sandwicensis	'ahu'awa, marsh cypress	1,3,4,5	dry to med	K/ O/ Mo/ M	clumping shrub	cinder, wetland
Delissea undulata	'oha	2,3,4	dry to med	WM (ex)/ H	palm-like tree	cinder
Dianella sandwicensis	'uki'uki	2,(3),4	dry to med	K/ O/ Mo/ L/ M/ H	clumping lily	organic, cinder
Dioscorea alata	uhi	1,(3),4	dry to wet	HI	herbaceous vines	cinder, organic
Dioscorea bulbifera	pi'oi	1,(3),4	dry to wet	HI	herbaceous vines	cinder, organic
Dioscorea pentaphylla	pi'ia	1,(3),4	dry to wet	HI	herbaceous vines	cinder, organic
Diospryos sandwicensis	lama	3,4	dry to med	K/ O/ Mo/ L/ M/ H	tree	cinder, coral, organic
Dodonaea viscosa	'a'ali'i	2,3,4,5	dry to med	Ni/ K/ O/ Mo/ L/ M/ H	sprawling shrub/ small tree	organic, cinder
Dubautia menziesii	na'ena'e	2,4	dry to med	EM	clumping shrub	cinder, basalt
Dubautia scabra	kupaoa, na'ena'e	2,4	dry to med	Mo/ L/ M/ H	mat-forming shrub	cinder, organic
Eleocharis obtusa	kohekohe	1,2,4	wet	K/ O/ Mo/ M/ H	clumping grass	organic
Eragrostis variabilis	'emoloa	2,3,4	dry to med	Ku/ Mi/ PH/ Li/ La/ N/ HI	clumping grass	sand, basalt, organic
Erythrina sandwicensis	wiliwili	2,3,4	dry	HI	small tree	cinder
Eugenia malaccensis	'ohi'a 'ai, mountain apple	1,(3),4	med to wet	HI	medium shade tree	organic, cinder
Fimbristylis cymosa spathacea	mau'u aki' aki', fimbristylis	3,5	dry to med	Mi/ La/ FF/ Ni/ K/ O/ WM/ H	clumping grass	sand, coral chips
Fimbristylis dichotoma	forked fimbry	1,4	wet	K/ O/ Mo/ M/ H	clumping grass	organic
Fragaria chiloensis sandwicensis	ohelo papa, beach strawberry	1,2, (3),4,5	med	EM/ H	spreading herb	organic, cinder
Gardenia brighamii	nanu, na'u	2,3,4	dry to med	O/ Mo (ex)/ L/ WM (ex)/ H (ex)	shrub like tree	sand, cinder
Gossypium tomentosum	ma'o, hawaiian cotton	3,5	dry to med	Ni/ K/ O/ Mo/ L/ M/ Ka	spreading shrub	cinder, coral, organic
Haplostachys haplostachya	honohono	2,4	dry to med	K (ex)/ M (ex)/ H	forb/herb	organic
Hedoytis centranthoides	manono	2,4	med	K/ O/ Mo/ L/ M/ H	clustered shrub	sand, cinder, coral, organic

Uses	Propagation	Federal Status	Distribution Status	Height	Spread	Elevation
food, thatch, beer medicine	cutting	no status	polynesian	6'	3'	sea to 4000'
food, dye, medicine, repels ants	division	no status	polynesian	3'	2'	1500' to 6000'
medicinal, lei	division	no status	endemic	vine	vine	sea to 1000'
weaving, rope, filter, medicine	rhizome division	no status	native	2'	8'	sea to 300'
'awa strain, medicine, cordage	seed	no status	endemic	6'	6'	sea to 1000'
N/A	seed	endangered	endemic	20'	3'	500' to 4000'
cordage, lei, dye	seed, cutting	no status	endemic	2'	2'	1000' to 9000'
roots can be eaten once cooked	roots	no status	polyneisan	vine	vine	sea to 9000'
roots and bulbs can be eaten once cooked	roots, tubers	no status	polynesian	vine	vine	sea to 9000'
roots can be eaten once cooked	roots	no status	polynesian	vine	vine	sea to 9000'
food, torch, wood	seeds	no status	endemic	12'	15'	sea to 3000'
fishing, spears, dye, lei	seed	no status	native	6'	8'	sea to 9000'
N/A	seed, cutting	no status	endemic	7'	4'	1500' to top
roots used to scent kapa	seed, cutting	no status	endemic	1'	2'	225' to 7500'
water gardens, roots can be sub-merged	seed, cutting	no status	native	1'	1'	sea to 6200'
thatch, edible seeds	division	no status	endemic	1'	2'	sea to 1000'
canoe, fishing, surfboards, lei	seed, cutting, air layers	no status	endemic	20'	20'	sea to 1000'
food, medicine, wood for hale	seed, cutting	no status	polynesian	35'	25'	sea to 1800'
toothbrush, ear pick, divination	seed, vegetative trans-plant	no status	native	6"	1'	sea to 1000'
water gardens, roots can be sub-merged	seed, cutting	no status	native	6"	1'	sea to 1000'
food	division	no status	endemic	6"	1.5'	sea to 9000'
lei wood and dye	seed, cutting, air layers, grafting	endangered	endemic	15'	15'	1000' to 2000'
swab, dye, medicinal, food	seed	no status	endemic	5'	8'	sea to 1000'
mint	seed	endangered	endemic	1'	2'	3000' to 9000'
berries are laxative	seed	no status	endemic	3'	2'	1000' to 3000'

Scientific Name	Common Name	Zone	Watering	Island Distribution	Growth Form	Soils
Hedoytis littoralis	pilo, au	1,3,5	dry to wet	K/ O/ Mo/ EM/ H	clustered shrub	sand, cinder, coral, organic
Heliotropium anomalum argenteum	hinahina ku kahakai	(3),5	dry to med	Ni/ K/ O/ Mo/ M (r)/ H (r)/ L (ex)/ Ka (ex)	clumping succulent	sand, coral
Heteropogon contortus	pili	3	dry to med	HI	spreading grass	sand, basalt, organic
Hibiscus brackenridgei	ma'o hau hele	2,(3),4,5	dry to med	L/ M/ H	spreading shrub	cinder, coral, organic
Hibiscus furcellatus	'akiohala, hau hele	1,4	dry to wet	K/ O/ M/ H	spreading shrub	cinder, coral, organic
Hibiscus kokio	kokio		dry to med	K/ O/ Mo/ M/ H?	shrub-like tree	cinder, organic
Ipomoea batatas	'uala, sweet potato	1,2,3,4	med to wet	HI	herbaceous vine	sand, organic
Ipomoea imperati	hunakai	1,2,3,4,5	dry to wet	Ni/ K/ O/ Mo/ M	spreading vine	cinder, organic
Ipomoea indica	koali'awa, morning glory	1,2,3,4,5	dry to wet	Ku/ Mi/ Li/ La/ N/ HI	spreading vine	cinder, organic
Ipomoea pes-caprae	pohuehue, beach morning glory	5	dry to med	Ku/ Mi/ Li/ La/ FF/ N/ HI	vine	sand, coral
Ipomoea tuboides	huna kai, hawaiian moon flower	2,3,4	dry to med	HI	vine	cinder
Jacquemontia ovalifolia	pa'u o hi'iaka	3,4,5	dry to med	HI	mat forming vine	cinder
Kokia drynarioides	kokia	1,2,3,4	dry to med	H	medium tree	cinder, organic
Lagenaria siceraria	bottle gourd	1,(3),4,5	dry to med	HI	fruiting vine	organic
Lipochaeta connata	nehe	2,(3),4	med to wet	K/ WM	sprawling shrub	organic
Lipochaeta intergrifolia	nehe	(3),4,5	dry to med	Ku/ La/ HI	grass like shrub	basalt, sand, coral chips
Lipochaeta rockii	nehe	2,3,4	dry to med	Mo/ M/ Ka/ H	partially-woody shrub	cinder
Lipochaeta succullenta	nehe	1,(3),4	dry to wet	Ni/ K/ O (r)/ Mo/ M/ Ka/ H	short mat forming shrub	organic
Lycium sandwicense	'ohelo kai, 'ae 'ae	3,5	dry to med	HI	small sprawling shrub	basalt, coral, sand
Lysimachia mauritiana	spoonleaf yellow loosestrife	1,3,5	dry to wet	Ni/ K/ Mo/ M/ northwest H	sprawling shrub	cinder, organic, coral
Marsilea villosa	'ihi'ihilauakea	1,3,4	dry to wet	Ni/ O/ Mo	spreading fern	clay, organic
Melanthera lavarum	nehe	2,3,4,5	dry to med	Mo/ L/ M/ Ka/ northwest H	partially woody shrub	cinder
Metrosideros polymorpha	ohi'a lehua	1,2,3,4,5	dry to wet	O/ Mo/ L/ M/ H	flowering evergreen tree	cinder, organic, bassalt
Microlepia strigosa	palapalai	1,2,(3),4	dry to wet	M/ H	clumping fern	organic, cinder

Uses	Propagation	Federal Status	Distribution Status	Height	Spread	Elevation
berries are laxative	seed	no status	endemic	2'	1'	1000' to 3000'
medicinal	cutting	no status	endemic	1'	2'	sea to 1000'
thatch, dye, medicinal	seed, vegetative trans-plant	no status	native	1'	2'	sea to 700'
Hawaii state flower	seed, cutting	endangered	endemic	3'	2'	sea to 3000'
cordage, 'ohai game, adz handle	seed, cutting	no status	native	6'	6'	sea to 1000'
lei, cordage	cutting	no status	endemic	30'	6'	1000' to 3000'
root tuber is edible once cooked	cutting	no status	polynesian	1	15	sea to 7500'
N/A	seed, cutting	no status	native	vine	30'	sea to 4000'
psychoactive seeds	seed, cutting	no status	native	vine	30'	sea to 4000'
cordage, fishing	seed, cutting	no status	native	1'	20'	sea to 1500'
medicinal, fish bait, beer, food	seed, cutting	no status	endemic	1'	10'	sea to 3000'
medicinal, laxative	seed, cutting	no status	endemic	6"	6'	sea to 1000'
dye	seed, cutting	endangered	endemic	20'	20'	1500' to 6000'
food, utensils, drum, container	seed	no status	polynesian	1'	50'	sea to 7600'
N/A	seed, cutting	no status	endemic	2	4	1000' to 1300'
N/A	seed, cutting	no status	endemic	1'	5'	sea to 1000'
N/A	seed, cutting	no status	endemic	2'	2'	sea to 1000'
N/A	seed, cutting	no status	endemic	2'	5'	sea to 300'
N/A	seed, cutting	no status	native	2'	2'	sea to 1000'
lei	seed	no status	native	2'	2'	sea to 1000'
pond plant	rhizome	endangered	endemic	6"	10'	200' to 1000
N/A	seed, cutting	no status	endemic	3'	3'	sea to 1000'
wood for images (ki'i), posts, rafters, and fences	seed, cutting, air layer	no status	endemic	25'	25'	sea to 1000'
head, neck, and wrist lei	division	candidate	native	3'	3'	sea to 5800'

Scientific Name	Common Name	Zone	Watering	Island Distribu-tion	Growth Form	Soils
Musa acuminata	maia, apple banana	1,2,(3),4	dry to wet	HI	tree-like herb	cinder, organic
Myoporum sandwicense	naio, false sandal-wood	2,3,4,5	dry to med	Ni/ K/ O/ Mo/ L/ M/ H	variable shrub/ tree	cinder, sand coral, basalt, organic
Myrsine lessertiana	kolea	2,4	dry to wet	K/ O/ Mo/ L/ M/ H	small tree	cinder, organic
Nephrolepsis exaltata	kupu kupu	1,2,3,4,5	dry to wet	HI exc. Ka	spreading fern	cinder, organic
Nesoluma polynesicum	keahi	3	dry	K/ O/ Mo/ L/ M	small tree	cinder, organic
Nestegis sandwicensis	olopua, hawaiian olive	3,4	dry to med	K/ O/ Mo/ L/ M/ H	large tree	cinder, organic
Nothocestrum latifolium	'aiea, halena	1,2,3,4	dry to wet	K/ O/ Mo/ L/ M	small tree	cinder
Nototrichium humile	kulu'i	2,3,4	dry to med	O/ EM	tall shrub	cinder
Nototrichium sandwicense	kulu'i	2,3,4	dry to med	HI	shrub/tree	cinder, organic
Ochrosia haleakalae	holei	2,3,4	dry to med	EM/ H	shrub-like tree	cinder
Osteomeles anthyllidifolia	'ulei, eluehe	2,3,4	dry to med	K/ O/ Mo/ L/ M/ H	spreading shrub	cinder, coral, bassalt, sand
Pandanus tectorius	hala, puhala	1,(3),4,5	dry to wet	Ni/ K/ O/ Mo/ L/ M/ H	medium shade tree	cinder, sand, coral , organic
Peperomia blanda	'ala'ala wai nui	2,3,4	dry to med	Ni/ K/ O/ Mo/ L/ M/ H	spreading succu-lent herb	basalt, cinder
Peucedanum sandwicense	makou	1,(3),5	dry to wet	K/ O/ Mo/ WM/ EM	small upright herb	cinder, organic
Phyllanthus distichus	pamakani mahu	4	medium	K/ O/ Mo/ L/ WM/ EM	spreading shrub	cinder, organic
Piper methysticum	'awa	1,4	med to wet	HI	clumping herb	cinder, organic
Pipturus albidus	mamake, hawaiian tea	1,2,4	dry to wet	K/ O/ Mo/ L/ M/ H	shrub/small tree	clay, cinder, organic
Pisonia brunoniana	papala kepau	2,4	medium	O/ Mo/ L/ M/ H	small tree	cinder, organic
Pisonia grandis	papala	1,(3),4	med to wet	Li/ M	small tree	cinder, organic
Pisonia sandwicensis	alulu, papala kepau	2,4	medium	K/ O/ Mo/ L/ M/ H	small tree	cinder, organic
Pisonia umbellifera	papala kepau	1,4	medium	K/ O/ Mo/ L/ M/ H	small tree	cinder, organic
Pittosporum confertifolium	ho'awa	2,4	dry	O/ L/ M/ H	shrub/tree	cinder, organic
Pittosporum glabrum	hoawa	1,2, (3),4,5	dry to wet	K/ O/ Mo/ L/ M	small tree	organic, cinder
Plectranthus parviflorus	'ala 'ala wai nui	1,3,4,5	dry to wet	Ni/ K/ O/ Mo/ L/ M/ H	spreading herb	cinder, organic
Pleomele auwahiensis	halapepe	2,3,4	dry to med	Mo/ M	columnar tree	cinder
Plumbago zeylanica	'ilie'e	2,3,4	dry to med	HI	sprawling shrub	sand, cinder, organic

Uses	Propagation	Federal Status	Distribution Status	Height	Spread	Elevation
medicinal, kapa, cordage, food, dye	rhizome division	no status	polynesian	20'	20'	sea to 10,000
torches, woodwork, construction	seed, cutting, air layer	no status	native	10'	10'	sea to 9000'
dye, wood for houses, canoes, and kapa anvil	seed, cutting	no status	endemic	15	12	700' to 7000'
edible tubers	rhizome division	no status	endemic	3'	8'	sea to 6000'
wood	seed, cutting	no status	native	15'	15'	sea to 300'
spears, dagger, digging, adze	seed, cutting	no status	endemic	50'	30'	100' to 4000'
lei, wood	seed	no status	endemic	30'	15'	1500' to 5000'
lei	seed, cutting	endangered	endemic	15'	10'	900' to 2300'
fireworks in 'ohai game	seed, cutting	no status	endemic	10'	10'	sea to 3000'
lei, dye, wood	seed	candidate	endemic	15'	8'	500' to 3900'
digging, ukeke, spears, dye, lei	seed, cutting	no status	native	4'	6'	sea to 3000'
thatch, cordage, paint brush	seed, cutting	no status	native	35'	25'	sea to 1000'
dye, medicinal	seed, cutting	no status	native	1'	1'	sea to 3000'
medicine	seed	threatened	endemic	4'	4'	sea to 1000'
edible fruits	seed, cuttings, air layer	no status	endemic	2'	2'	sea to 3000'
roots are narcotic	cutting, tissue culture	no status	polynesian	9'	3'	sea to 1500'
kapa, cordage, leaves are used for tea	seed, cutting	no status	endemic	8'	8'	sea to 6000'
fruit sap used to trap birds	seed	no status	native	15'	15'	150' to 2000'
bird trap glue	seed, cutting	no status	native	10'	10'	sea to 4000'
fruit sap used to trap birds	seed	no status	endemic	15'	15'	150' to 4000'
fruit sap used to trap birds	seed	no status	native	25'	20'	150' to 2000'
wood, kahuna magic	cutting	no status	endemic	30'	10'	600' to 7200'
wood	seed, cutting	no status	endemic	15'	15'	780' to 6500'
landscape	seed, cutting	no status	native	3'	6"	sea to 4200'
idols, lei	seed, cutting	no status	endemic	20'	2'	700' to 4000'
tattoo pigment, medicinal	cutting	no status	native	1'	4'	sea to 2000'

Scientific Name	Common Name	Zone	Watering	Island Distribution	Growth Form	Soils
Portulaca lutea	'ihi	1,(3),5	dry to med	Mi/ Li/ La/ GP/ FF/ Ne/ N/ O/ Mo/ L/ M/ H	dwarf shrub	sand, cinder
Portulaca molokiniensis	'ihi	3,5	dry	MI/ Ka	dwarf shrub	sand, cinder
Portulaca villosa	'ihi	3,5	dry	N/ K/ O/ Mo/ L/ M/ Ka/ H	spreading herb	sand, cinder, coral
Pritchardia arecina	lo'ulu hawane	1,(3),4	dry to wet	EM	medium tree	sand, cinder, coral
Pritchardia forbesiana	lo'ulu lelo	1,3,4,5	dry to wet	WM	medium tree	sand, cinder, coral
Pritchardia glabrata	loulu	2,(3),4	dry to wet	WM (lao)	medium tree	sand, cinder, coral
Pritchardia hillebrandi	lo'ulu lelo	1,3,4,5	dry to wet	Mo	medium tree	sand, cinder, coral
Psilotum complanatum	moa nahele	2,4	med to wet	HI exc. Ni, Ka	epiphytic fern ally	tree fern
Psilotum nudum	moa, moa kula, whisk fern	1,2,3,4	dry to wet	HI	epiphyte	cinder
Psuedognaphalium sandwicensium	'ena'ena, puheu	2,3,4,5	dry to med	EM/ H	creeping herb	sand, coral, cinder, basalt
Psydrax odorata	ohe'e, walahe'e, ohe'e	3,4	dry to med	K/O/Mo/L/M/H	shrub/tree	clay, cinder, organic
Rauvolfia sandwicensis	hao	2,3,4	dry	Ni/K/O/Mo/L/M/H	small tree/tall shrub	clay, organic
Reynoldsia sandwicensis	'ohe makai	3	dry	Ni/O/Mo/L/M/H	large tree	cinder, organic
Rhus sandwicensis	neneleau	1,4	med to wet	K/ O/ Mo/ M/ H	shrub-like tree	organic, cinder
Rumex skottsbergii	pawale	2,3,4	dry	Mo/ M/ H	round shrub	cinder
Saccharum officinarum	sugar cane, ko	1,2, (3),4,5	dry to med	HI	culm-forming grass	cinder, organic, sand, coral
Sadleria cyatheoides	'ama'u, ama'u ama'u	1,2,3,4	dry to wet	HI exc. Ni, Ka	tree fern	cinder, organic
Santalum ellipticum	costal sandalwood, 'iliahi	2,3,4	dry to med	La(ex)/HI	sprawling shrub-like tree	cinder, sand, coral, basalt, organic
Santalum freycinetianum	'a'ahi	2,3,4	med to dry	M/ K/ O/ Mo/ L	sprawling shrub-like tree	sand, cinder, organic
Santalum haleakalae	'iliahi	2,4	med to dry	EM	sprawling shrub-like tree	cinder, organic
Scaevola chamissoniana	mountain naupaka	1,2,4	dry to wet	Mo/L/M/H	small flowering shrub	cinder, organic
Scaevola coriacea	dwarf naupaka	3,4,5	dry to med	Ni(ex)/ K(ex)/O(ex)/ Mo/ L(ex)/M/H(ex)	dwarf shrub	clay, sand, cinder, coral
Scaevola gaudichaudii	ridgetop naupaka	2,(3),4	dry to med	K/ O/ Mo/ L/ M/ H	shrub	cinder, organic
Scaevola taccada	beach naupaka	3,4,5	dry to med	Ku/ Mi/ PH/ Li/ La/ FF/ HI	spreading shrub	sand, coral, basalt, organic

Uses	Propagation	Federal Status	Distribution Status	Height	Spread	Elevation
N/A	cutting	no status	native	6"	3'	sea to 1000'
N/A	cutting	no status	endemic	2'	2'	sea to 1000'
N/A	seed, cutting	no status	endemic	2'	5'	sea to 1600'
roofing, fishing heiau offering	seed	no status	endemic	40'	10'	1000' to 3000'
roofing, fishing heiau offering	seed	no status	endemic	25'	15'	sea to 1000'
roofing, fishing heiau offering	seed	no status	endemic	6'	6'	1000' to 2000'
roofing, fishing heiau offering	seed	no status	endemic	25'	15'	sea to 1000'
N/A	rhizome division	no status	native	2'	2'	2000' to 3200'
bundled as a broom	division, spores	no status	native	1'	1'	sea to 3000'
N/A	cutting	candidate	endemic	2'	1'	sea to 9000'
dye, wood for farming and fishing tools	seed	no status	native	50'	50'	30' to 3800'
religious purposes, poisonous	seed, cutting, air layering	no status	endemic	20'	15'	sea to 3000'
stilts	seed, cutting	no status	endemic	20'	20'	1000' to 3000'
massage sticks, calabash	seed, rhizome	no status	endemic	15'	15'	500' to 5000'
lei	seed, cutting	no status	endemic	6'	6'	sea to 3000'
food, dye, thatch	cutting	no status	polynesian	15'	5'	sea to 9000'
roofing, pathways, glue, dye	dividing root shoots, spores	no status	endemic	5'	20'	sea to 5000'
dye, lei, trade, fragrant wood, hemi-parasitic	seed, cutting, air layering	no status	endemic	8'	8'	sea to 3000'
dye, lei, trade, fragrant wood, hemi-parasitic	seed, cutting, air layering	no status	endemic	20'	20'	820' to 3100'
dye, lei, trade, fragrant wood, hemi-parasitic	seed, cutting, air layering	no status	endemic	15'	8'	2500' to 9000'
lei	seed, cutting	no status	endemic	4'	4'	1000' to 6000'
N/A	seed, cutting	endangered	endemic	1'	6'	sea to 3000
dye	seed, cutting	no status	endemic	6'	8'	250' to 2500'
food, medicine, mask defog	seeds, cutting, air layering, tissue culture	no status	native	6'	8'	sea to 1000'

Scientific Name	Common Name	Zone	Watering	Island Distribution	Growth Form	Soils
Schiedea globosa	ma'oli'oli	1,5	med to wet	O/Mo/M/H	sprawling shrub	cinder, coral
Schizostachyum glaucifolium	'ohe	1,4	wet	HI	giant grass	cinder, organic
Senna gaudichaudii	kolomona	2,3,4,5	dry to med	K/ O/ Mo/ L/ M/ Ka/ H	small shrub	cinder, organic
Sesbania tomentosa	'ohai	3,4,5	dry	Ne/ N (ex) / HI	shrub/tree	sand, cinder, coral
Sesuvium portulacastrum	'akulikuli, sea purslane	1,(3),5	med to wet	Mi/ PH/ Li/ La/ Ne/ HI	spreading succulent	cinder, coral
Sida fallax	'ilima papa	3,4,5	dry to med	Mi/ N/ HI	sprawling shrub	coral, bassalt, cinder
Sisyrinchium acre	mau'u ho'ula 'ili	2,4	med to wet	EM/ H	clumping grass	cinder, organic
Solanum nelsonii	'akia, beach solanum	3,4,5	dry to med	Ku/ Mi (ex)/ PH/ La (ex)/ N/ Ni/HI	shrub	sand, coral, bassalt
Sophora chrysophylla	mamane	2,4	medium	K/ O/ Mo/ L/ M/ H	medium tree	cinder, organic
Sphenomeris chinensis	pala'a, lace fern	1,2,4	med to wet	HI exc. Ni, Ka	creeping fern	cinder
Sporobolus virginicus	aki aki	3,5	dry to wet	Mi/ La/ HI	spreading grass	sand, brackish pond
Styphelia tameiameiae	pukiawe	2,3,4	dry to med	K/ O/ Mo/ L/ M/ H	small shrub	cinder, organic
Tacca leontopetaloides	pia, arrowroot	1,(3),4,5	dry to med	HI	upright herb	cinder, organic
Tephrosia purpurea	'auhuhu	3,4,5	dry to med	HI	small shrub	cinder, organic
Tetraplasandra hawaiensis	'ohe makua	1,4	med to wet	Mo/ L/ M/ H	shade tree	cinder, organic
Thespesia populnea	milo	1,(3),5	med to wet	Ni/ K/ O/ Mo/ M/ H	medium tree	sand, coral
Touchardia latfolia	olona	1,(3),4	med to wet	K/ O/ Mo/ L/ M/ H	wood shrub	organic, cinder
Vaccinium reticulatum	'ohelo	2	dry to med	K (r)/ O (r)/ Mo (r)/ M/ H	small shrub	cinder, organic
Vigna marina	nanea	1,5	med to wet	K/ O/ Mo/ M/ H	spreading vine	sand, cinder, organic, coral
Vitex rotundifolia	pohinahina	(3),5	dry to medium	Ni/ K/ O/ Mo/ L/ M/ H	sprawling shrub	sand, coral, organic
Wikstroemia monticola	'akia	3,4,5	dry	EM	sprawling shrub	clay, cinder, orgainic, coral
Wikstroemia uvaursi	'akia, Molokai osmanthus	3,4,5	dry	O/ Mo/ M	sprawling shrub	clay, cinder, orgainic, coral
Zingiber zerumbet	awapuhi kuahiwi , shampoo ginger	1,(3),4	med to wet	HI	spreading herb	cinder, organic

Uses	Propagation	Federal Status	Distribu-tion Status	Height	Spread	Elevation
N/A	seed, cutting	no status	endemic	1	1	sea to 1000'
musical instruments, fishing pole, irriga-tion pipe	rhizome division	no status	polynesian	30'	20'	200' to 1000'
lye, dye	seeds	no status	native	5'	5'	sea to 4000'
lei	seed, cutting	endangered	endemic	30'	45'	sea to 3000'
biological water treatment, food	cutting	no status	native	6"	2'	sea to 1000'
food, lei, medicinal	seed	no status	native	6"	3'	sea to 1000'
dye, temporary tattoo	seed	no status	endemic	2'	2'	2000' to 9000'
poisonous	seed, cutting	no status	endemic	3'	3'	sea to 100'
lei, construction	seed	no status	endemic	20'	20'	1000' to 3000'
lei	rhizome division	no status	native	5'	5'	sea to 4000'
N/A	rhizome division	no status	native	6"	6"	sea to 500'
wood, lei	seed, air layer	no status	native	6'	6'	50' to 9000'
food, medicine	seed, tubers	no status	polyneisian	5'	2'	sea to 1000'
contains tephrosin fish poison	seed	no status	polynesian	2'	2'	sea to 1000'
wood	seeds, cutting	no status	endemic	30'	30'	500' to 2600'
dye, medicine, oil, drum, bowls	seed, cutting	no status	native	30'	30'	sea to 3000'
worlds strongest natural fiber	seed	no status	endemic	15'	2'	200' to 3600'
lei, food	seed	no status	endemic	4'	3'	2000' to 9000'
nitrogen-fixing	seed	no status	native	6"	6'	sea to 1000'
tea, lei	seed, cutting	no status	native	3'	4'	sea to 1000'
lei, fish poison	seed, cutting	no status	endemic	3'	3'	sea to 1400'
lei, fish poison	seed, cutting	no status	endemic	3'	3'	sea to 1400'
shampoo, food, kapa scent	division	no status	polynesian	3'	2'	sea to 3000'

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